CONTINUOUS FIBER CERAMIC COMPOSITES

Project Fact Sheet

CFCC Cyclone Components For Particle Separation

Benefits

CFCCs offer all the advantages of ceramics - resistance to heat, erosion, and chemical activity - while adding toughness and thermal shock resistance. CFCCs enable substantial increase in energy efficiency and a decrease in life cycle costs in a broad range of industrial applications. Using CFCC materials for high-temperature particle separator components permits:

- higher operating temperatures resulting in increased steam and energy production
- emissions reduction due to more complete combustion
- increased efficiency
- increased service life to help lower plant maintenance costs

Applications

End-users of the CFCC particle separator components include chemical processors, power generation facilities, municipal solid waste incinerators, and others. The use of a cyclone instead of a filter bag house or candle filter for particle separation is basically dependent on three conditions:

- the particles should separate from one another easily.
- the system temperatures are too hot for filter materials.
- and the ash or solids being filtered are also recycled back into the system.

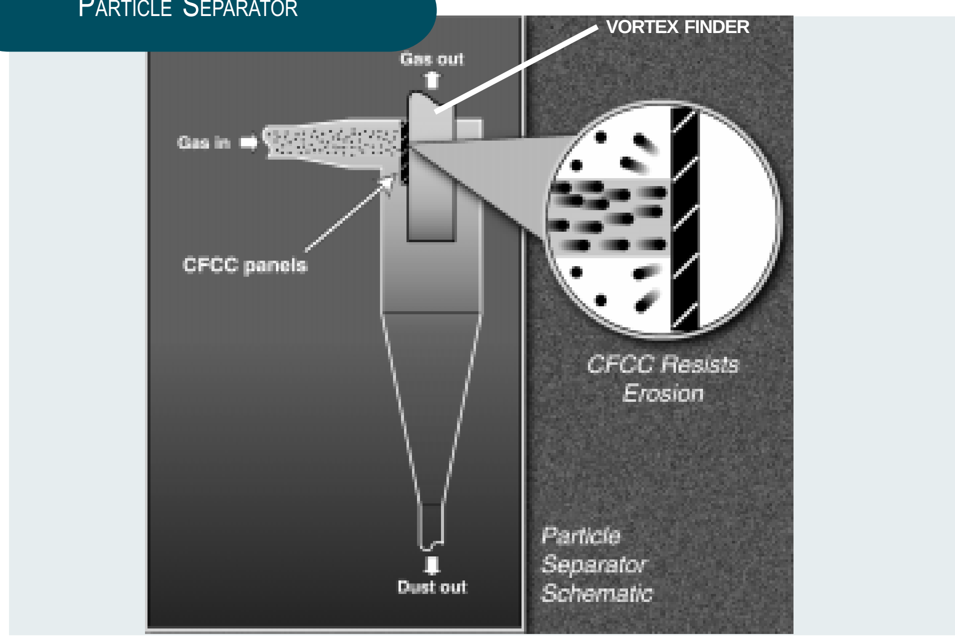
Chemical vapor infiltration (CVI) process used to fabricate CFCC cyclone components

The U.S. Department of Energy's Office of Industrial Technologies (OIT) initiated the Continuous Fiber Ceramic Composite (CFCC) Program in 1992 as a collaborative effort between industry, National Laboratories, universities and government.

Through support of the CFCC Program, AlliedSignal Composites, Incorporated is fabricating silicon carbide matrix CFCC components using the chemical vapor infiltration (CVI) process. The CVI process involves fabricating ceramic fiber preforms in the shape of final parts and infiltrating with chemical vapors that react at elevated temperatures to form a silicon carbide matrix on and between the fibers. Fibers such as silicon carbide are woven, braided, or wound to produce the desired shape.

AlliedSignal Composites and Foster Wheeler are developing CVI matrix CFCC cyclone particle separator components for use in a municipal waste incinerator. Cyclone particle separators have a hollow cylindrical tube inside called the vortex finder column (see schematic below). In cyclone tests, CFCC panels were placed on the outside of the vortex finder directly in the erosion stream and on the inside of the vortex finder exposed to corrosive gases. The CFCC material successfully provided protection from heat, corrosion, and erosion superior to that of currently used superalloys. It resisted corrosion and erosion from acids, chlorides, sulfides, trash and sand.

Particle Separator



Schematic of a separator used in a municipal waste incinerator.

Project Description

Goal: The goals of this project are to: 1) develop functional and cost-effective methods for producing CFCC components using the CVI process for application in cyclone particle separators; and 2) demonstrate processing methods suitable for cost effective manufacturing.

In addition, this project is identifying and testing energy saving industrial applications for CFCC particle separator components. Based on current testing, the CFCC material components or panels are more consistent in performance than metal materials. Additional testing is required to build exposure hours and design experience.

As exhibited by this project, the CFCC Program is addressing the critical need for advanced materials that are lighter, stronger, and more corrosion-resistant than metals. The Program strives to advance processing methods for reliable and cost-effective ceramic composite materials to a point at which industry assumes the full risk of development and commercialization. The long-term strategy is to develop the primary processing methods for reliable and cost-effective fabrication of CFCCs and to perform application-specific testing which will meet the needs of a wide range of energy saving applications in industry. These industries include: power generation, agriculture, aluminum, steel, chemicals, forest products, glass, metal casting, mining and refining.

Progress and Milestones

- Designed a laboratory test to simulate high-temperature ash exposure of CFCC panels. The simulated ash proved to be much more severe than the ash from the actual plant test panels. The laboratory tests were conducted on CFCC panels for 1,000 hours at two temperatures (1,400^{0} F and 1,650^{0} F) with the CFCC material surviving with 30% to 75% strength.

- Experimental metal plates and CFCC plates were exposed for approximately 300 hours during natural-gas-fueled start-up, plus another 2,000 hours burning refuse mixed with sand to promote fluidizing in a major municipal waste plant. One plate of each material was placed directly in the erosion stream at the inlet of the particle separator and on the 'outside' wall of the vortex finder center column. The exposed CFCC panels suffered no damage and tensile bars cut from the panels retained their original properties. The remaining CFCC panels will continue to be exposed until the next normal plant shutdown, resulting in over 9,000 hours of total exposure time.

- Work is beginning on the design of CFCC panels and attachments for a large panel four feet by eight feet. The large panel would address the problem of the high erosion inlet area at a test site. The field test would be in service for two years and testing would last for 16,000 hours prior to inspection.

- Developed a mathematical model for life prediction of chemical vapor infiltration (CVI) processed SiC/SiC material in high alkaline environments. Test data from new field test compositions and temperatures are being used to validate the model.

Project Partners

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